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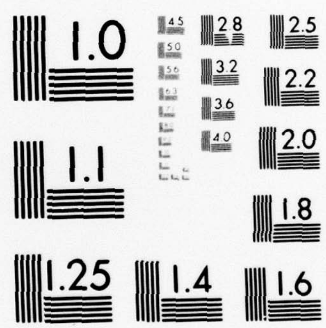

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Large, bakeable, rotatable ultra high vacuum seals capable of operation at 10^{-11} torr are described. They employ doubly differentially pumped commercially available spring loaded Teflon seals. A static version is very convenient for quick access as it requires nearly negligible sealing force other than atmospheric force.

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UHV Application of Spring Loaded Teflon Seals

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Introduction

Demountable Seals in Ultra High Vacuum (UHV) chambers are conventionally made with metal gaskets. Compared to the O-Ring seals used in high vacuum equipment such seals have a number of limitations. The large sealing forces required dictate the use of thick flanges and numerous bolts - drawbacks when a large quick-access port is desired. Metal gaskets are generally not reusable. Furthermore, metal gaskets do not permit dynamic seals. While rotary motions can be introduced with bellows sealed feedthroughs, utilities such as cooling water, electrical connections or cryogenic fluids require separate stationary feedthroughs and flexible connecting lines. The necessary flexibility often presents fabrication difficulties. The provision of multiple differential pumping manifolds for a rotating member is very difficult with these techniques unless the pumps are placed inside the vacuum chamber.

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We describe below two applications of spring load Teflon gaskets to overcome these restrictions. The first is a rotating flange which is suitable for a sample mount or molecular beam detector. The second is a large (46 cm) quick access port.

Seal Design

Teflon (Polytetra Fluoroethylene) is a good vacuum material. It is bakeable (to at least 250°C) and after bakeout has an outgassing rate comparable to baked metal surfaces.[1] Teflon has a low coefficient of friction, making it a good material for a dynamic seal. Furthermore, Teflon filled with MoS_2 is available with improved lubrication properties. There are, however, two obvious difficulties in using Teflon for a bakeable vacuum seal: (1) Teflon has both a high thermal expansion coefficient and poor creep characteristics so that deformation and leaks result after bakeout[2]; and (2) the permeability (and leakage in a dynamic seal) causes a non-negligible gas load for typical U. H. V. systems.[3]

The deformation problems can be overcome by the use of spring loaded Teflon seals available commercially.[4] The influence of permeability on leakage can be reduced to an acceptable level by the use of multiple seals and differential pumping. Experience with dynamic seals of this type in non-bakeable high vacuum equipment[5] suggests that for a dynamic seal three Teflon gaskets should be used while for a static seal two are sufficient. There

is a considerable safety factor included in these estimates to insure a high degree of reliability of the final design.

The design of the rotating seal is shown in figure 1. To prevent damage to the seals from rubbing, a 15% MoS_2 filled Teflon alloy was used. The first stage of differential pumping is provided by a mechanical rotary pump. Pumping speed is limited by the 1/4" tubing used for connection to the pump. The second stage of pumping is provided by an 11ℓ/sec (noble gas stable) ion pump. The rotating flange is supported by two ball bearings [6] which are lightly preloaded to provide the required rigidity. Since the bearings are made of 400 series stainless steel and the flange of 304 stainless steel, differential thermal expansion during bakeout could damage the balls in the bearing. To prevent this problem the inner and outer races of the bearing were split before installation.

Our design also included a lightly spring load metal–metal sliding seal (not shown in fig. 1) similar to that described by Merrill. [7] The performance of the rotating seal proved to be adequate without this added stage of differential pumping and we have not used it. If higher performance than that described below is required, the sliding seal and an additional differential pumping slot could be added.

Figure 2 shows the design of a 46 cm inside diameter access port. Two Teflon seals of the same composition as above were used. A third "seal" was

provided by making the flange with a small step so that metal to metal contact occurred on the innermost region. This allows for two stages of differential pumping as above. The flange is mounted on a hinge to facilitate access and is fastened with 10 3/8" bolts.

Results

Both of these seals have been in use for over a year on a molecular beam surface scattering apparatus. [8] They have proved to be very reliable and contribute negligibly to the gas load on the system. This system is baked to 200° C and has a base pressure $\sim 5 \times 10^{-11}$ torr. Pressure rise when moving the rotating flange is always $< 10^{-10}$ torr and usually unobservable. The rotating flange moves smoothly. The torque required is ~ 150 ft./lb.

The pressure at the 11 ℓ/sec. ion pump is typically $2 - 4 \times 10^{-8}$ torr while that at the first stage seal is $\sim 5 \times 10^{-1}$ torr.

The leakage across the seals was measured by leaking air into the first differential pumping stage and observing the pressure rise in the second. Leak rates of $\sim 10^{-6}$ ℓ/sec are typical for the rotary seals. From this figure and the measured pressure in the second differential pumping stage the estimated gas load from static leakage is 10^{-13} torr ℓ/sec, a negligibly small value.

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Stan Zielenski made great contributions to this work in the design and preparation of drawings.

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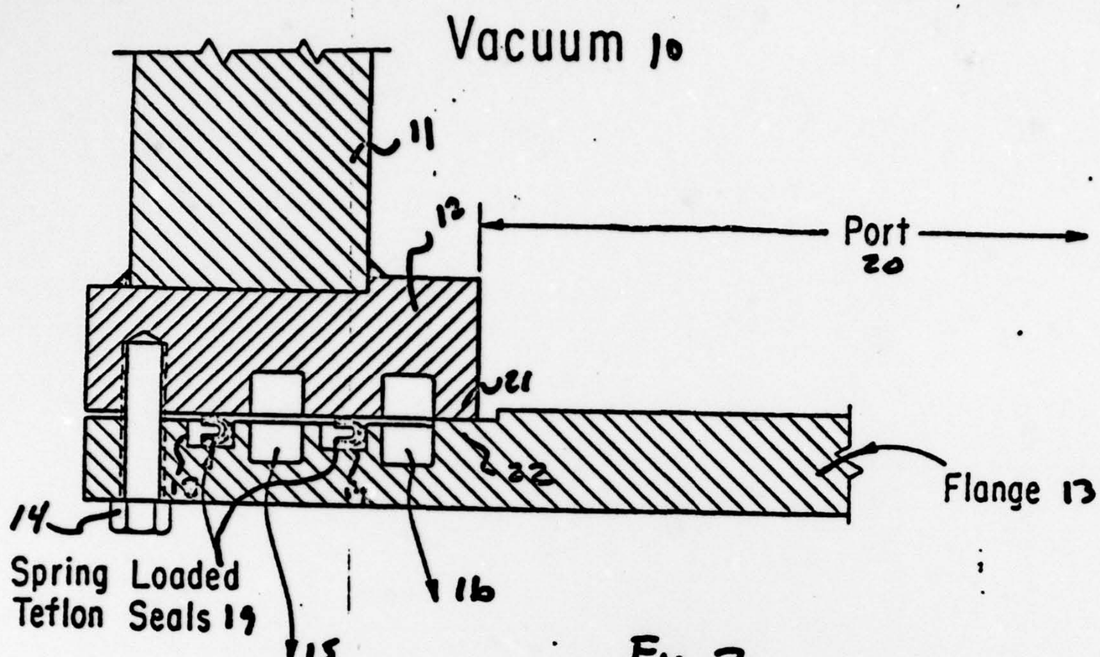
FIGURE CAPTIONS

Figure 1	**Rotating Flange with UHV Seal**
Figure 2	**UHV Quick Access Port**



Vacuum 10
11
12
Port
20
21
22
Flange 13
14
Spring Loaded
Teflon Seals 19
15
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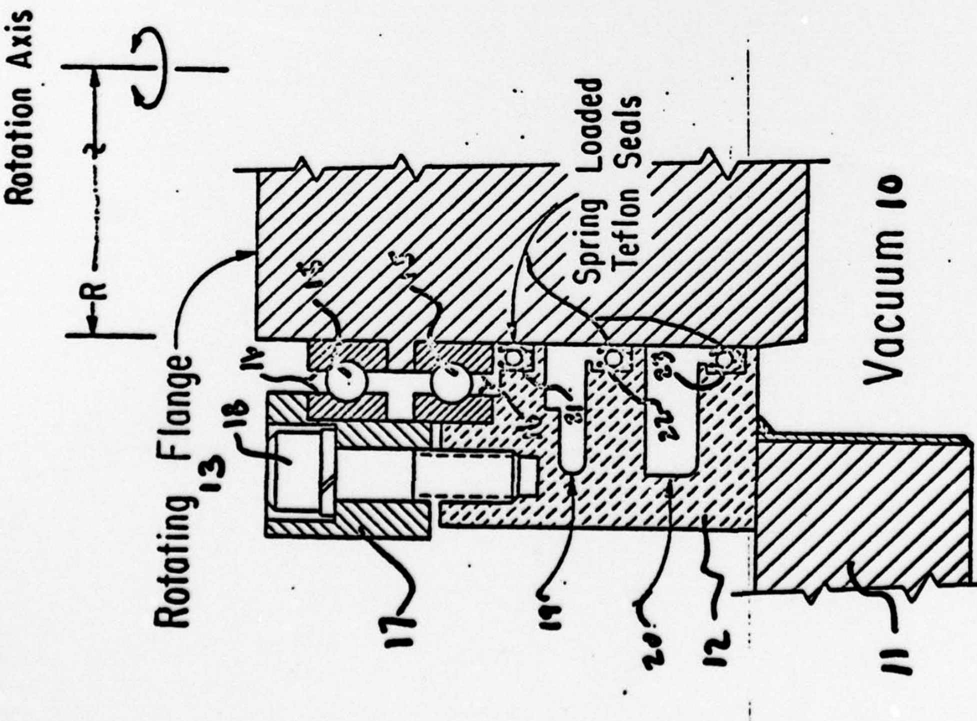
Fig. 2



Rotation Axis
R
r
Rotating Flange
13
18
Spring Loaded
Teflon Seals
Vacuum 10
17
19
20
12
11

Fig. 1